

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization International Bureau



(43) International Publication Date
30 June 2005 (30.06.2005)

PCT

(10) International Publication Number
WO 2005/059629 A1

(51) International Patent Classification⁷: **G02B 27/48, G11B 20/00**

[BE/BE]; c/o Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL). **OPHEY, Willem, G.** [NL/NL]; c/o Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL). **AKKERMANS, Antonius, H., M.** [NL/NL]; c/o Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).

(21) International Application Number:
PCT/IB2004/052527

(74) Agents: **UITTENBOGAARD, Frank et al.**; Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).

(22) International Filing Date:
24 November 2004 (24.11.2004)

(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(25) Filing Language: English

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI,

(26) Publication Language: English

(30) Priority Data:
03104677.4 12 December 2003 (12.12.2003) EP

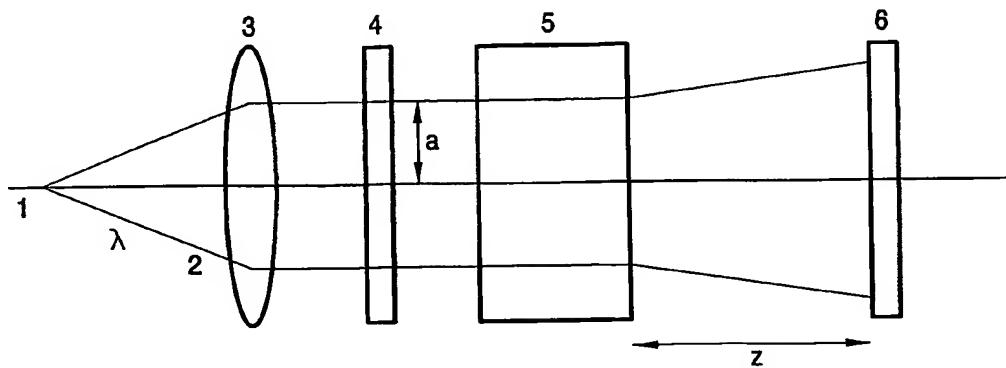
(71) Applicant (*for all designated States except US*): **KONINKLIJKE PHILIPS ELECTRONICS N.V.** [NL/NL]; Groenewoudseweg 1, NL-5621 BA Eindhoven (NL).

(72) Inventors; and

(75) Inventors/Applicants (*for US only*): **STALLINGA, Sjorerd** [NL/NL]; c/o Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL). **SKORIC, Boris** [NL/NL]; c/o Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL). **TUYLS, Pim, T.**

[Continued on next page]

(54) Title: A METHOD AND APPARATUS FOR DETECTION OF A SPECKLE BASED PHYSICALLY UNCLONABLE FUNCTION



WO 2005/059629 A1

(57) Abstract: An optical arrangement of at least a coherent light source (1), a strongly scattering object (5) (the PUF), and a pixelated photo-detector (6), wherein the pixels are comparable in size with the bright and dark patches of the speckle pattern produced by coherent radiation traversing the scattering object (5). Quantitatively, the pixel size should be roughly λ/NA , where λ is the wavelength, and (i) $NA=a/z$ for free-space geometry, with a being the beam radius and z being the distance between the exit surface of the PUF (5) and the pixelated detector (6), or (ii) NA is the numerical aperture of a lens (7) in an imaging geometry. In a preferred embodiment of the invention, there are tentative requirements that the pixels should be at least smaller than $\eta_{max}\lambda/NA$ and preferably larger than $\eta_{min}\lambda/NA$, where (in an exemplary embodiment) $\eta_{max}=5$ and $\eta_{min}=0.05$, say. It will be understood by a person skilled in the art that the present invention is concerned with the optical arrangement of the PUF (5) and the photo-detector (6), rather than the photo-detector (6) *per se*.



FR, GB, GR, HU, IE, IS, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declaration under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM,*

ZW, ARIPO patent (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)

Published:

— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.